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FLOOD INSURANCE STUDY

CITY OF MUSKEGO, WISCONSIN
WAUKESHA COUNTY

JUNE 1, 1982

Federal Emergency Management Agency

COMMUNITY NUMBER - 550486

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Flood Boundary and Floodway Map Index

Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index

Flood Insurance Rate Map

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FLOOD INSURANCE STUDY

CITY OF MUSKEGO, WAUKESHA COUNTY, WISCONSIN

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Muskego, Waukesha County, Wisconsin, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert Muskego to the regular program of flood insurance by the Federal Emergency Management Agency (FEMA). Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these Federally-supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.3(d). In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgments

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by Carl C. Crane, Inc. for the Federal Emergency Management Agency under Contract No. EMW-C-0065. This study was completed in October 1980.

1.3 Coordination

Streams requiring detailed study were identified at a meeting attended by representatives of the Study Contractor, FEMA, the Wisconsin Department of Natural Resources and

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representatives of the City of Muskego on June 5, 1979. Results of the hydrologic analyses were coordinated with the Wisconsin Department of Natural Resources, Flood Plain Management Section, and the Engineering Department of the City of Muskego.

On June 3, 1981, the results of this study were reviewed and accepted at a final coordination meeting attended by representatives of the Study Contractor, FEMA and community officials.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Muskego, Waukesha County, Wisconsin. The area of study is shown on the Vicinity Map (Figure 1).

The areas selected for detailed study were chosen with priority given to existing and projected development or proposed construction for the next five years, through October 1985.

Detailed studies within the corporate limits of Muskego were completed for Muskego Canal, Jewel Creek, Unnamed Tributary of Muskego Canal, Tess Corners Creek, Tess Corners Creek Tributary North and Lake Denoon Tributary. Detailed data for the Unnamed Tributary to Wind Lake-1 were taken from the Racine County, Wisconsin Flood Insurance Study (Reference 12). A total of approximately ten river miles were studied by detailed methods.

An unnamed tributary referred to as Tess Corners Creek Tributary South was studied by approximate methods.

Lake stages were also computed for Little Muskego Lake, Muskego Lake and Lake Denoon.

2.2 Community Description

The City of Muskego is located in the southeast portion of Waukesha County, Wisconsin, approximately ten miles southwest of Milwaukee.

The City of Muskego is bordered on the north and west sides by the unincorporated areas of Waukesha County, on the east by the unincorporated areas of Milwaukee County, and on the south by the unincorporated areas of Racine County. The total land area contained within the city limits is approximately 36 square miles.

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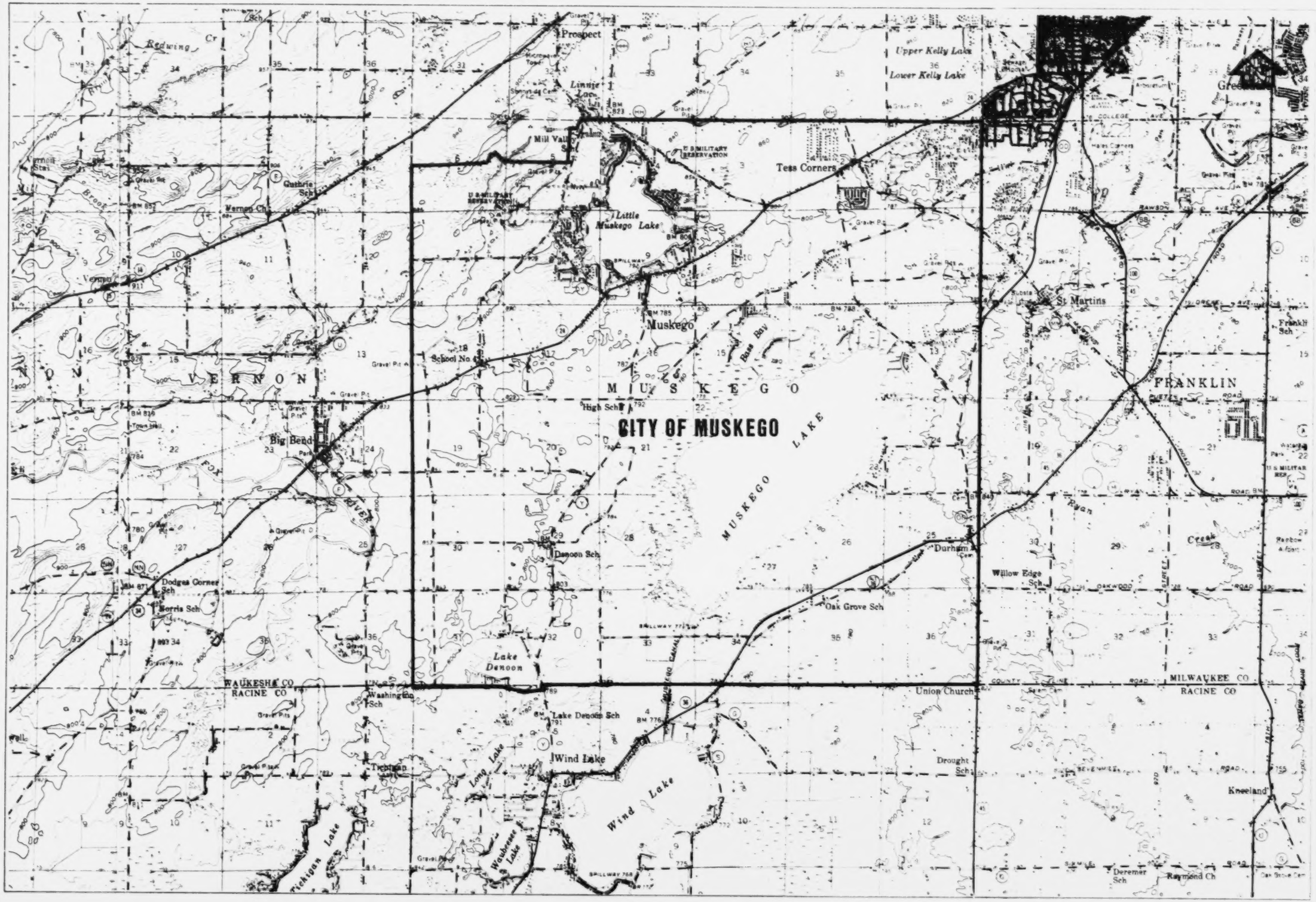

APPROXIMATE SCALE

0 1 2 3 4 MILES

VICINITY MAP

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI

(WAUKESHA CO.)

FIGURE 1

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The surface of Waukesha County is a gently undulating plain mainly sloping southward. There are only a few points of prominent relief and these are located in the western part. A belt of hummocky drift hills, the Kettle morain, associated with numerous lakes, lies across the western part of the county. In the eastern part, the valleys are broad and the uplands gently sloping. In the western part, the topography is more abrupt.

The county is mainly drained by the Fox River (of Illinois) whose headwaters gather in the central part and flow south. The eastern part is drained by streams flowing eastward to Lake Michigan, and the western part by streams flowing west to the Rock River. There are numerous lakes in the county, the principal ones being Muskego Lake in the southeastern part, and the large group of lakes in the northwestern part, between Pewaukee and Oconomowoc.

The Niagara limestone is a bedrock formation in the eastern three-fourths of the county. Along the western border is a belt five to ten miles wide of the Cincinnati shale and the Galena-Platteville (Trenton) limestone. The glacial drift of variable thickness overlying the rock forms a well-defined belt of terminal moraine extending north and south in the western part of the county. The thickness of the Niagara limestone is variable on account of the extensive erosion of this formation. At Waukesha it has a known thickness of 230 feet, but the probable maximum thickness on ridges thinly covered with drift may reach 350 to 400 feet, and of the Galena-Platteville (Trenton) limestone 250 to 300 feet (Reference 1).

The City of Muskego was incorporated in 1964. In 1970, its population was listed at 11,573 with a 1978 estimate of 15,241, as obtained from the 1980 State of Wisconsin Blue Book (Reference 2). About 20 per cent of the total acreage is in residential use, 45 per cent open lands, and the remainder in all other uses (including commercial, industrial and transportation).

The Muskego Canal, which flows southerly through the City, is the principal flooding source in Muskego. Its length of approximately 3.5 miles extends from its mouth at Wind Lake, just below the southern corporate limits, through Muskego Lake

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to the spillway at Little Muskego Lake. Its total drainage area encompasses approximately 35 square miles.

Jewel Creek, which flows southerly through the City, is a tributary of Little Muskego Lake. Its length of approximately 0.8 mile extends from its mouth at Little Muskego Lake to Lake Linnie Lac, just above Muskego's northern corporate limits. Its total drainage area is approximately 11.6 square miles.

The Unnamed Tributary of the Muskego Canal flows easterly through the City. Its length of approximately 1.5 miles extends from its mouth at Muskego Canal to State Highway 24, all within the Muskego corporate limits.

The Lake Denoon Tributary flows southerly in the southwest corner of the City. Its length of 0.6 mile is also contained within the corporate limits. It has a drainage area of approximately 0.6 square mile.

Tess Corners Creek flows southeasterly through the far northeast corner of the City. Its length of approximately nine miles extends from its mouth at the Root River in Milwaukee County, through Muskego to approximately three miles north of the City. There are also two small tributaries of Tess Corners Creek within the corporate limits.

The climate in southeastern Wisconsin is characterized by wide variations in temperatures. Average summer and winter temperatures for the year 1973-1977 ranged from 74 degrees F. to 6 degrees F., respectively. Annual average precipitation of the region is 32 inches with an average recorded snowfall of 42 inches. Precipitation is normally higher in the spring and summer months (Reference 2 and Reference 3).

2.3 Principal Flood Problems

The past history of flooding on the streams within the City of Muskego indicates that flooding may occur during any season of the year. Most major floods within the City of Muskego have occurred in the summer and fall and are usually the result of intense thunderstorms.

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Damaging floods have been recorded for the City of Muskego in 1933, 1960 and 1973. Although no discharge measurements are available for any of these floods, the most recent 1973 event had an estimated recurrence interval of approximately fifty years for the Muskego Canal basin.

Obstructions to flood flow can be both natural and manmade. Natural obstructions include trees and other vegetation growing along stream banks and floodway areas. Manmade obstructions include all bridges, dams and dikes within the study reach. Any of the manmade obstructions, and some of the natural obstructions such as trees for example, can collect floating debris and thereby create a greater flood hazard due to greater depths (backwater effect) upstream of these areas. Since the amount of debris is an indeterminate factor, only existing physical characteristics can be considered in determining the backwater effect. (See Figures 2 through 9 for future flood heights at various locations).

2.4 Flood Protection Measures

Although the dams within the City of Muskego were constructed to create recreational lakes, the storage capacity behind these structures does cause considerable attenuation of peak discharges and, therefore, helps minimize flood damages.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10, 50, 100 or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10, 50, 100 and 500-year floods, have a 10, 2, 1 and 0.2 per cent chance, respectively, of being equalled or exceeded during any year.

Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood

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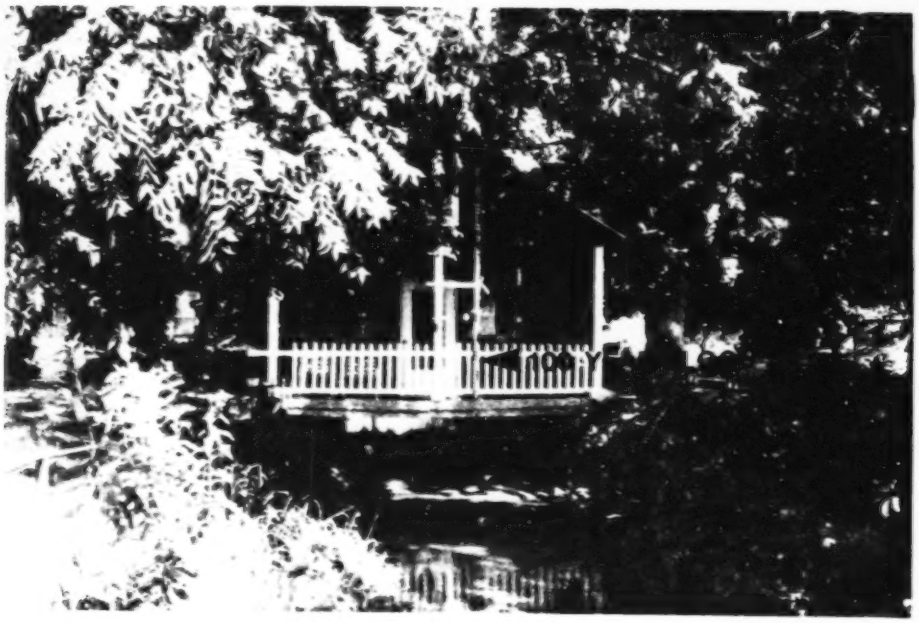

FIGURE 2
SECTION R, HOUSE OVER TESS CORNERS ROAD
100-YEAR FLOOD ELEVATION = 797.96

FIGURE 3
SECTION S, TESS CORNERS CREEK, TESS CORNERS ROAD
100-YEAR FLOOD ELEVATION - 799.49

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FIGURE 4
SECTION N, TESS CORNERS CREEK, TESS CORNERS ROAD
100-YEAR FLOOD ELEVATION = 794.26

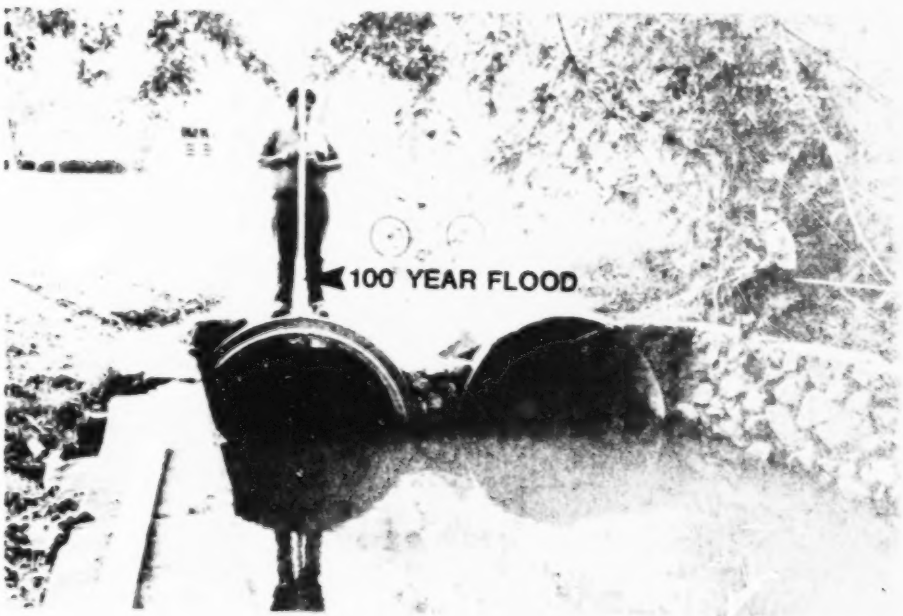

FIGURE 5
SECTION Q, TESS CORNERS CREEK, PRIVATE DRIVE
100-YEAR FLOOD ELEVATION = 796.84

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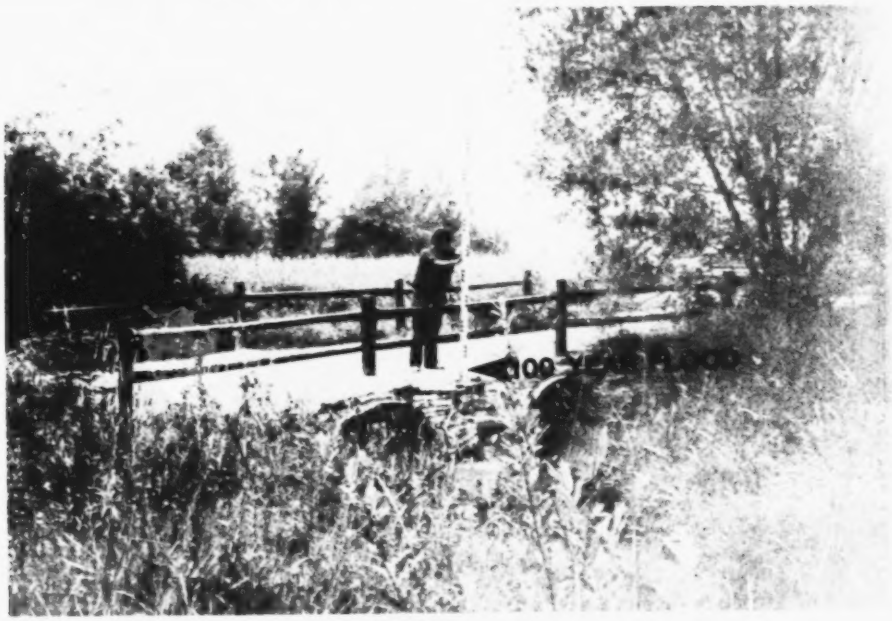

FIGURE 6
SECTION N, MUSKEGO CANAL, RIESE ROAD
100-YEAR FLOOD ELEVATION = 778.90

FIGURE 7
SECTION S - MUSKEGO CANAL, PRIVATE DRIVE
100-YEAR FLOOD ELEVATION = 781.30

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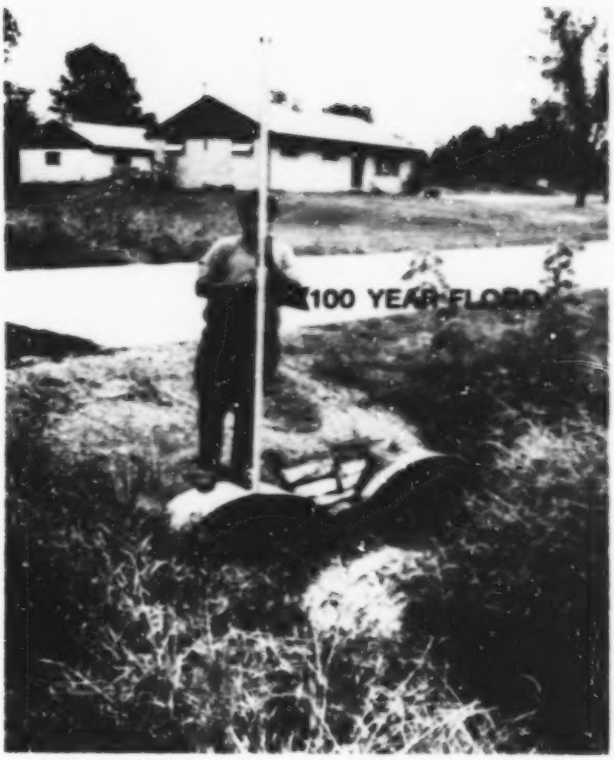

FIGURE 8
SECTION V, TESS CORNERS CREEK, BROOKSIDE DRIVE
100-YEAR FLOOD ELEVATION = 806.55

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which equals or exceeds the 100-year flood (one per cent chance of annual occurrence) in any 50-year period is about 40 per cent (four in ten), and for any 90-year period, the risk increases to about 60 per cent (six in ten).

The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

The hydrologic analysis for Muskego Canal was transferred directly from "A Comprehensive Plan for the Fox River Watershed" completed by the Southeastern Wisconsin Regional Planning Commission in 1969 (Reference 4). This publication developed discharges using the Soil Conservation Service TR20 Hydrologic Computer Model (Reference 7). The principal function of this model is to compute a unit hydrograph for each basin, as well as excess rainfall for each of the different frequency storms. The resulting discharges were checked for validity and were deemed acceptable for this study.

For the detailed studies of Jewel Creek and the Unnamed Tributary of Muskego Canal, the hydrology was investigated using the methodology outlined in the National Engineering Handbook (Reference 6). Using this procedure, the time of concentration and the time of peak runoff were computed for the basins and a unit hydrograph was developed.

The expected 6-hour rainfall for the desired frequency events were obtained from Technical Paper 40 (Reference 3) and distributed into 30-minute amounts as described in the SCS criteria for design storms.

A 6-hour duration storm was chosen since it was determined to be the "effective duration" for areas having an average annual precipitation of approximately 30 inches.

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Rainfall excess was computed from accumulated rainfall using an SCS runoff equation which equates runoff as a function of soil type, antecedant moisture conditions and land use (Reference 6).

For the detailed studies of Tess Corners Creek, the Tess Corners Creek Tributary North and the unnamed tributary of Lake Dennoon, TR-20 basin models (Reference 7) were established. These hydrologic models were analyzed using the same SCS criteria as listed for Jewel Creek and the unnamed tributary of Muskego Canal above.

The peak discharges computed for each basin were compared to data obtained from similar gaged basin and the States Multiple Regression Equations. These equations identify drainage areas, main channel slope, per cent lakes and marsh, areal factor, and mean snowfall as the independent variables. The derivation of these equations is described in detail in "Estimating Magnitude and Frequency of Floods in Wisconsin" by Duane H. Conger (Reference 8).

Little Lake Muskego provides considerable attenuation of the Jewel Creek discharges prior to its entry into the Muskego Canal.

The storage capacity of the Lake Linnie Lac and Little Lake Muskego were also evaluated using the Modified Puls routing technique and the Corps of Engineers HEC-1 computer program (Reference 9). The lakes do provide a significant attenuation of peak discharges contributed from the sub-basins directly north of the City.

The discharges computed reflect the present land use within the basins. Future development without regard to changes in the runoff characteristics of the basins could substantially increase these flows.

Peak discharges for the 10, 50, 100 and 500-year floods of each flooding source studied in detail in the community are shown in Table 1.

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TABLE 1 - SUMMARY OF DISCHARGES

Flooding Source and Location	Drainage Area (square miles)	Peak Discharge (cfs) 10-Year	50-Year	100-Year	500-Year
Muskego Canal at:					
South Corporate Limits	34.5	290	340	350	365
Woods Road	14.0	250	310	340	405
Jewel Creek at:					
Mouth at Little Muskego Lake	10.0	775	1250	1450	2000
Unnamed Tributary of Muskego Canal at:					
Mouth at Muskego Canal	1.4	175	300	350	500
Lake Denoon Tributary at:					
Mouth at Lake Denoon	0.55	115	200	240	360
Kelsey Drive	0.25	70	125	150	225
Tess Corners Creek					
East corporate limits	6.3	560	880	1030	1430
Just below confluence of:					
Tess Corners Creek Tributary	5.2	420	670	770	1040
At Tess Corners Road	3.5	310	480	530	750
About 400 feet upstream of Janesville Road	3.1	320	530	620	870
Tess Corners Creek Tributary North	0.26	50	80	90	130
Above Janesville Road	0.25	40	70	80	115

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Lake stages computed for Lake Denoon, Muskego Lake and Little Muskego Lake are found in Table 2.

TABLE 2

SUMMARY OF ELEVATIONS

	10-year	50-year	100-year	500-year
Lake Denoon	780.7	781.1	781.2	781.5
Muskego Lake	773.5	773.8	774.1	774.2
Little Muskego Lake	793.7	794.1	794.2	794.4

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along each flooding source studied in detail.

The cross sections used for the study were obtained from 2-foot contour maps made available by the City (Reference 10).

All bridge elevation data and structural geometry for the backwater analysis of the flooding source studied were obtained by field surveys by the Study Contractor. The channel soundings were also obtained by field measurement.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map.

Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and based on field observations of the streams and flood plain areas. See Table 3 for roughness values for various flooding sources studied.

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TABLE 3

CHANNEL ROUGHNESS FACTORS
(Manning's "n")

Flooding Source	Main Channel	Flood Plain
Muskego Canal	0.020 - 0.045	0.070 - 0.110
Jewel Creek	0.025 - 0.045	0.100 - 0.100
Unnamed Tributary of Muskego Canal	0.045	0.080
Lake Denoon Tributary	0.043 - 0.045	0.070 - 0.080
Tess Corners Creek	0.020 - 0.058	0.04 - 0.08
Tess Corners Creek Tributary North	0.045 - 0.055	0.060 - 0.075

Starting water surface elevations for the Unnamed Tributary of Muskego Canal were computed by a normal depth analysis utilizing the computer program, Hydraulic Review of Natural or Constricted Waterways (Reference 11).

Starting water surface elevations for Muskego Canal were taken from the Racine County Flood Insurance Study .

Starting water surface elevations for Tess Corners Creek were taken from the City of Franklin Flood Insurance Study (Reference 16).

Starting water surface elevations for Lake Denoon Tributary and Jewel Creek were established, based on the appropriate flood stages of the streams immediately downstream.

Starting water surface elevations for Tess Corners Tributary North were established by comparing the relative timing of the flood hydrographs, developed by the TR-20 Model, for the tributary with those for the Main Branch of Tess Corners Creek.

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It was found that the 100-year starting water surface elevation for Tess Corners Tributary North was approximately equal to the 10-year flood elevation on the Main Branch of Tess Corners Creek. Starting water surface elevations for other frequency storms were determined in a similar manner.

Water surface elevations of floods of the selected recurrence intervals were computed through use of the Corps of Engineers HEC-2 step backwater computer program (Reference 13). Flood profiles were drawn showing computed water surface elevations for floods of the selected recurrence intervals.

All hydraulic data for Unnamed Tributary to Wind Lake-1 were taken from the Racine County, Wisconsin Flood Insurance Study (Reference 12). The flood elevations were determined from the backwater elevations of the Unnamed Tributary to Wind Lake within Racine County.

The hydraulic analyses for this study were based on unobstructed flow. Obstructions due to floating debris or ice at manmade structures such as bridges and dams or natural channel restrictions can result in higher than normal water surface elevations.

Various dams and bridges on Jewel Creek and the Muskego Canal have been breached in the past. Conditions caused by the failure of these structures could increase flood flows and elevations considerably over those included within the scope of this study.

All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

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4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Insurance Administration as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community.

For each stream studied in detail, the boundaries of the 100 and the 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using topographic maps from the City of Muskego (Reference 10) at a scale of 1:1200 with a contour interval of two feet. In cases where the 100 and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

The boundaries of the 100 and 500-year floods are shown on the Flood Boundary and Floodway Map. Small areas within the flood boundaries may lie above the flood elevations and, therefore, may not be subject to flooding. Owing to limitations of the map scale and/or lack of detailed topographic data, such areas are not shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard.

For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights.

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Minimum standards of the FEMA limit such increases in flood in flood heights to 1.0 foot, provided that hazardous velocities are not produced. However, the Wisconsin Department of Natural Resources has established a policy that limits encroachment in the flood plain to 0.1 foot (Reference 15).

The floodways presented in this study were developed to reflect the existing effective flow limits. The results of these computations were tabulated at each cross section in Table 4 for all stream segments studied by detailed methods.

No floodways were computed for the Racine County Flood Insurance Study (Reference 12) due to local zone ordinances. For this reason no floodway was computed for Unnamed Tributary to Wind Lake-1.

As shown on the Flood Boundary and Floodway Map, the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 0.1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 9.

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
Tess Corners Creek								
A	18400	121	424	2.4	771.7	771.7	771.7	0.0
B	18810	433	1404	0.7	772.0	772.0	772.0	0.0
C	19355	690	3062	0.3	772.0	772.0	772.0	0.0
D	20225	745	2424	0.4	772.1	772.1	772.1	0.0
E	20875	583	1776	0.4	772.2	772.2	772.2	0.0
F	21625	473	433	1.8	772.8	772.8	772.8	0.0
G	22905	118	313	2.5	774.3	774.3	774.3	0.0
H	23825	14	190	4.1	778.6	778.6	778.6	0.0
I	24525	150	304	2.5	780.7	780.7	780.7	0.0
J	24990	378	442	1.7	781.6	781.6	781.6	0.0
K	25655	45	144	5.3	784.0	784.0	784.0	0.0
L	26330	91	154	5.0	789.0	789.0	789.0	0.0
M	26815	264	562	1.4	790.4	790.4	790.4	0.0
N	27265	221	321	2.4	794.3	794.3	794.3	0.0
O	27915	260	903	0.9	794.8	794.8	794.8	0.0
P	28495	130	327	1.7	795.2	795.2	795.2	0.0
Q	28991	165	153	3.5	796.9	796.9	796.9	0.0
R	29185	180	416	1.3	798.0	798.0	798.0	0.0
S	29605	89	255	2.1	799.8	799.8	799.8	0.0
T	29985	9	70	7.6	803.6	803.6	803.6	0.0
U	30085	8	66	8.0	804.1	804.1	804.1	0.0
V	31135	46	110	5.6	805.5	805.5	805.5	0.0
W	31425	35	89	7.0	807.0	807.0	807.0	0.0
X	31625	37	102	6.1	808.3	808.3	808.3	0.0
Y	32025	83	151	4.1	810.2	810.2	810.2	0.0
Z	32281	120	359	1.7	813.0	813.0	813.0	0.0
AA	32629	9	57	10.9	815.1	815.1	815.1	0.0

[1] FEET ABOVE MOUTH

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI

(WAUKESHA CO.)

FLOODWAY DATA

TESS CORNERS CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
Muskego Canal								
A	3400	250	1360	0.3	773.8	773.8	773.8	0.0
B	4964	42	317	1.1	773.9	773.9	773.9	0.0
C	5334	152	433	0.8	773.9	773.9	773.9	0.0
D	6163	450	509	0.7	774.0	774.0	774.0	0.0
E	6759	370	822	0.4	774.1	774.1	774.1	0.0
F	6856	433	586	0.6	774.1	774.1	774.1	0.0
G	19650	1290	1633	0.2	774.1	774.1	774.1	0.0
H	20780	216	248	1.4	774.2	774.2	774.2	0.0
I	21900	74	241	1.4	774.5	774.5	774.5	0.0
J	23200	69	238	1.4	774.8	774.8	774.8	0.0
K	23825	37	179	1.9	774.9	774.9	774.9	0.0
L	25145	48	100	3.4	776.1	776.1	776.1	0.0
M	26275	165	222	1.5	777.1	777.1	777.1	0.0
N	26748	102	183	1.9	778.9	778.9	778.9	0.0
O	27168	128	231	1.5	779.3	779.3	779.3	0.0
P	27658	170	246	1.4	779.5	779.5	779.5	0.0
Q	27888	116	204	1.7	779.7	779.7	779.7	0.0
R	28700	52	137	2.5	780.8	780.8	780.8	0.0
S	28872	131	135	2.5	781.4	781.4	781.4	0.0
T	29050	18	78	4.4	781.9	781.9	781.9	0.0
U	29814	97	197	1.7	783.7	783.7	783.7	0.0
V	30405	31	91	3.7	786.0	786.0	786.0	0.0
W	30665	36	95	3.6	786.8	786.8	786.8	0.0

[1] FEET ABOVE MOUTH

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI

(WAUKESHA CO.)

FLOODWAY DATA

MUSKEGO CANAL

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
JEWEL CREEK								
A	0	110	427	3.4	794.2	794.2	794.2	0.0
B	770	37	289	5.0	796.6	796.6	796.6	0.0
C	1260	150	291	5.0	797.3	797.3	797.3	0.0
D	1500	191	531	2.7	798.3	798.3	798.3	0.0
E	1790	94	235	6.2	799.1	799.1	799.1	0.0
F	2110	97	335	4.3	801.1	801.1	801.1	0.0
G	2700	166	248	5.8	806.6	806.6	806.6	0.0
H	3160	230	1018	1.4	807.4	807.4	807.4	0.0
I	3820	18	106	13.7	809.7	809.7	809.7	0.0
UNNAMED TRIBUTARY OF MUSKEGO CANAL								
A	509	284	187	1.9	778.9	778.9	778.9	0.0
B	904	333	436	0.8	779.8	779.8	779.8	0.0
C	1289	39	70	5.0	781.2	781.2	781.2	0.0
D	2006	320	796	0.4	786.3	786.3	786.3	0.0
E	2506	378	489	0.7	786.4	786.4	786.4	0.0
F	2866	654	2175	0.2	786.4	786.4	786.4	0.0
G	3216	679	1504	0.2	786.4	786.4	786.4	0.0
H	3813	591	1071	0.3	786.5	786.5	786.5	0.0
I	4717	529	1312	0.3	786.5	786.5	786.5	0.0
J	5272	312	890	0.4	786.6	786.6	786.6	0.0
K	5702	85	126	2.8	787.3	787.3	787.3	0.0
L	6542	66	106	3.3	791.6	791.6	791.6	0.0
M	7042	38	72	4.9	795.9	795.9	795.9	0.0
N	7338	160	135	2.6	799.0	799.0	799.0	0.0
O	7608	316	439	0.8	799.9	799.9	799.9	0.0

[1] FEET ABOVE MOUTH

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI

(WAUKESHA CO.)

FLOODWAY DATA

JEWEL CREEK - UNNAMED TRIBUTARY OF MUSKEGO CANAL

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
TESS CORNERS CREEK TRIBUTARY NORTH								
A	1055	72	65	1.2	806.8	806.8	806.8	0.0
B	1435	82	41	2.0	809.6	809.6	809.6	0.0
C	1970	97	53	1.5	815.6	815.6	815.6	0.0
D	2670	51	28	2.9	830.3	830.3	830.3	0.0
LAKE DENOON TRIBUTARY								
A	260	47	84	2.9	781.2	781.2	781.2	0.0
B	770	131	119	2.0	783.6	783.6	783.6	0.0
C	1220	55	82	2.9	785.9	785.9	785.9	0.0
D	1825	204	186	1.3	787.9	787.9	787.9	0.0
E	2330	72	58	4.1	792.5	792.5	792.5	0.0
F	2830	113	121	2.0	795.5	795.5	795.5	0.0
G	3341	119	74	3.2	804.2	804.2	804.2	0.0

[1] FEET ABOVE MOUTH

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI

(WAUKESHA CO.)

FLOODWAY DATA

TESS CORNERS CREEK TRIBUTARY NORTH
LAKE DENOON TRIBUTARY

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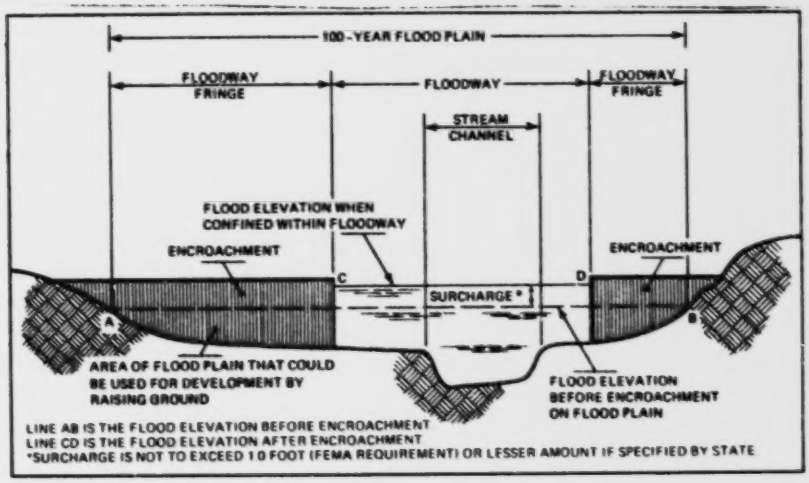
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE *
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FIGURE 9 - Floodway Schematic

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, FEMA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHFs), and flood insurance zone designations for each significant flooding source affecting the City of Muskego.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between

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the 10 and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 per cent of the reach.

Average Difference Between 10 and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 feet to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the City of Muskego are shown on the Flood Profiles and are summarized in the Flood Insurance Zone Data Table (Table 5).

5.2 Flood Hazard Factors (FHFs)

The Flood Hazard Factor is used to correlate flood information with insurance rate tables. Correlations between property damages from floods and their assigned FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10 and 100-year flood water-surface elevations expressed to the nearest one-half foot, and shown as a three-digit code. For example, if the difference between the water surface elevations of the 10 and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5 feet, the FHF is 050. When the difference between the 10 and 100-year flood water-surface elevations is greater than 10.0 feet, the accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of Muskego was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

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FLOODING SOURCE	PANEL [1]	ELEVATION DIFFERENCE [2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION [3] (FEET NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Tess Corners Creek							
Reach 1	0002	-1.7	-0.5	1.0	015	A3	Varies-See Map
Muskego Canal							
Reach 1	0006	-0.7	-0.3	0.2	005	A1	Varies-See Map
Reach 2	0001,0004 0005,0006	-0.7	-0.3	0.3	005	A1	Varies-See Map
Jewel Creek							
Reach 1	0001	-1.8	-0.5	1.0	020	A4	Varies-See Map
Unnamed Tributary of Muskego Canal							
Reach 1	0004	-0.9	-0.2	0.5	010	A2	Varies-See Map
Reach 2	0004	-1.8	-0.3	0.5	020	A4	Varies-See Map

[1] FLOOD INSURANCE RATE MAP PANEL [2] WEIGHTED AVERAGE [3] ROUNDED TO NEAREST FOOT

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI
(WAUKESHA CO.)

FLOOD INSURANCE ZONE DATA

TESS CORNERS CREEK - MUSKEGO CANAL - JEWEL CREEK
UNNAMED TRIBUTARY OF MUSKEGO CANAL

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FLOODING SOURCE	PANEL [1]	ELEVATION DIFFERENCE [2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION [3] (FEET NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
TESS CORNERS CREEK TRIBUTARY NORTH							
Reach 1	0002	-0.7	-0.2	0.3	005	A1	Varies-See Map
LAKE DENOON TRIBUTARY							
Reach 1	0006	-0.6	-0.2	0.3	005	A1	Varies-See Map
MUSKEGO LAKE	0004,0005,						
Reach 1	0006,0007	-0.6	-0.3	0.1	005	A1	774
LITTLE MUSKEGO LAKE							
Reach 1	0001,0002	-0.5	-0.1	0.2	005	A1	794
LAKE DENOON	0006	-0.5	-0.1	0.3	005	A1	781

[1] FLOOD INSURANCE RATE MAP PANEL [2] WEIGHTED AVERAGE [3] ROUNDED TO NEAREST FOOT

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI
(WAUKESHA CO.)

FLOOD INSURANCE ZONE DATA

MUSKEGO LAKE - LITTLE MUSKEGO LAKE - LAKE DENOON
TESS CORNERS CREEK TRIBUTARY NORTH - LAKE DENOON TRIBUTARY

BEST DOCUMENT AVAILABLE

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
UNNAMED TRIBUTARY TO WIND LAKE – 1[4]							
REACH 1 (BACKWATER FROM UNNAMED TRIBUTARY TO WIND LAKE)	0007	–0.6	–0.2	0.5	005	A1	VARIES–SEE MAP

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT
[4]DATA FOR THIS REACH TAKEN FROM THE RACINE COUNTY, WISCONSIN FIS

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI
(WAUKESHA CO.)

FLOOD INSURANCE ZONE DATA

UNNAMED TRIBUTARY TO WIND LAKE - 1

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Zones A1, A2, A3, A4 : Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods, base flood elevations shown, and zones assigned according to FHFs.

Zone B: Areas between the Special Flood Hazard Areas and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; or areas subject to 100-year flooding from sources with drainage areas of less than one square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

Table 5, "Flood Zone Data", summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Muskego is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by FEMA.

6.0 OTHER STUDIES

A Flood Insurance Study is currently being conducted for the Unincorporated Areas of Waukesha County (Reference 17). The results of this study will match exactly the City of Muskego Flood Insurance Study. The City of Muskego Flood Insurance Study is also in complete agreement with the Flood Insurance Study for the Unincorporated Areas of Racine County (Reference 12) which borders on the south corporate limits of the City. Base flood elevations were taken from the Racine County Report and used to delineate a flood plain just north of Union Church Drive in the southeastern portion of the City. The zone designation for this area was also taken from the Racine County Report.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purpose of the National Flood Insurance Program.

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A Flood Hazard Boundary Map has been published for the community (Reference 14). The differences between the Flood Hazard Boundary Map and this study are justified due to the more detailed nature of this Flood Insurance Study.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, 300 South Wacker Drive, Chicago, Illinois 60606.

8.0 REFERENCES AND BIBLIOGRAPHY

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11. Wisconsin Department of Natural Resources, Bureau of Water Regulation and Zoning, Hydraulic Review of Natural or Constricted Waterways (Bridge or Culvert), March 1978.

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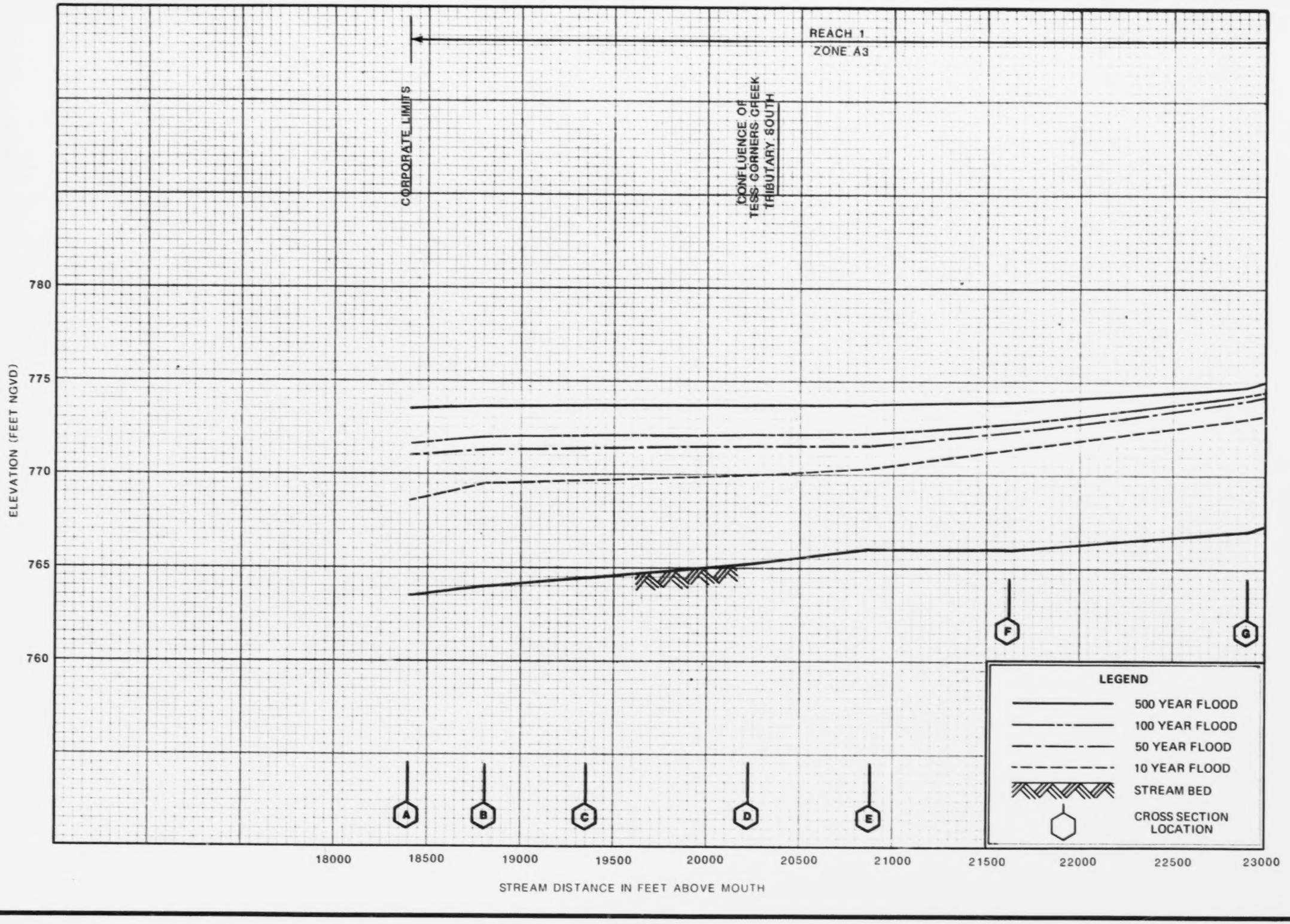

FLOOD PROFILES

TESS CORNERS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI
(WAUKESHA CO.)

01P

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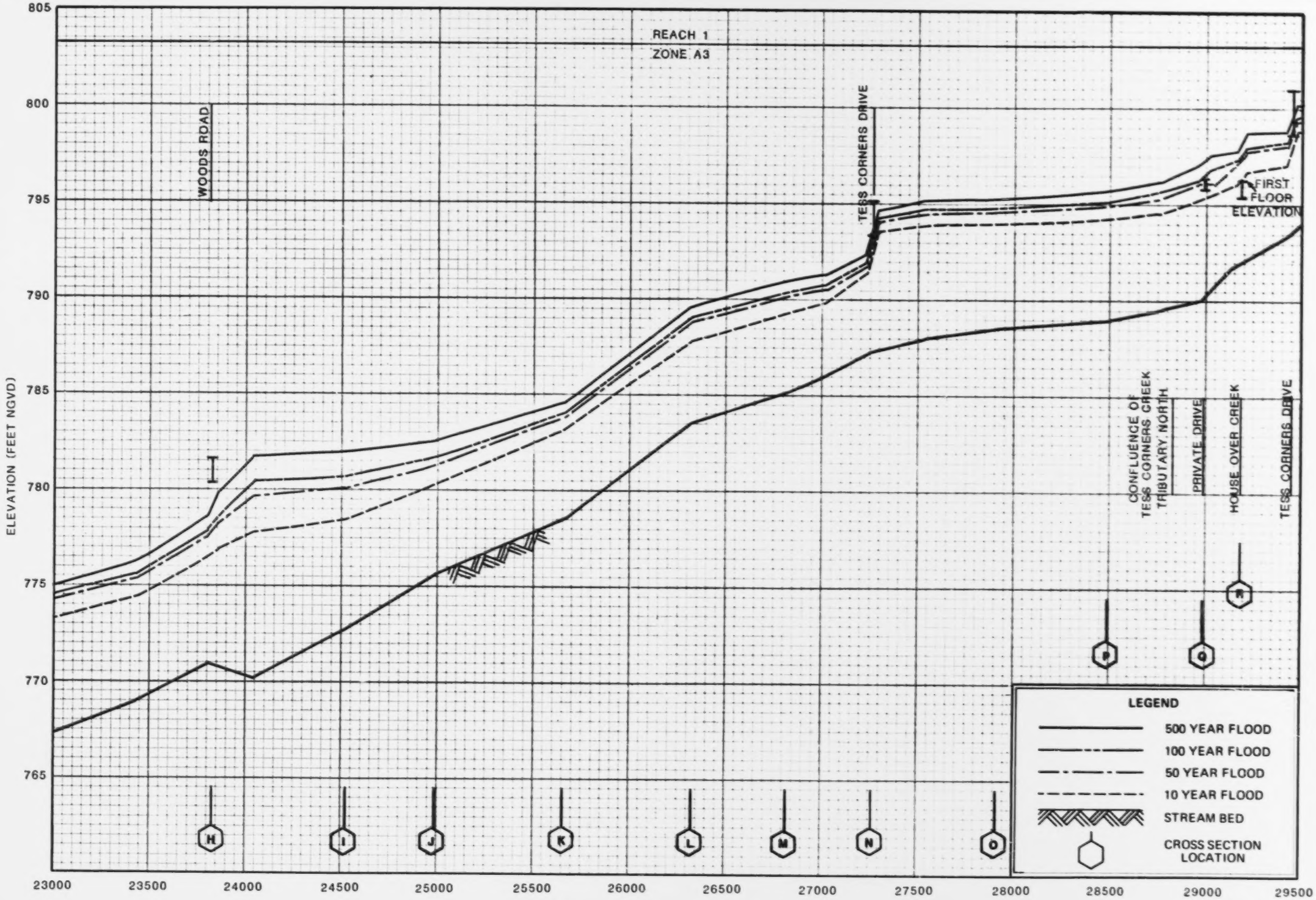

FLOOD PROFILES

TESS CORNERS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI
(WAUKESHA CO.)

02P

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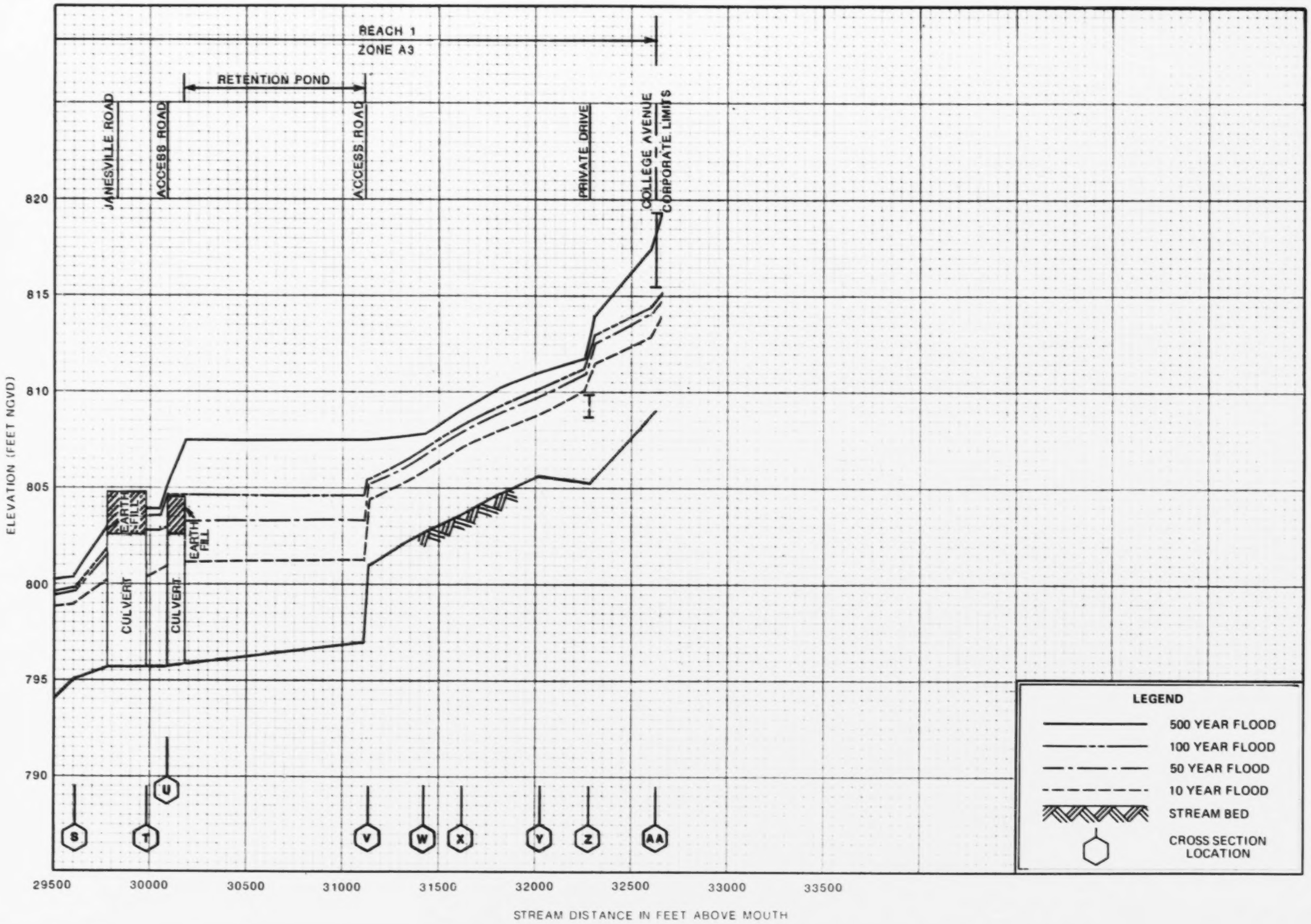

FLOOD PROFILES

TESS CORNERS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI
(WAUKESHA CO.)

03P

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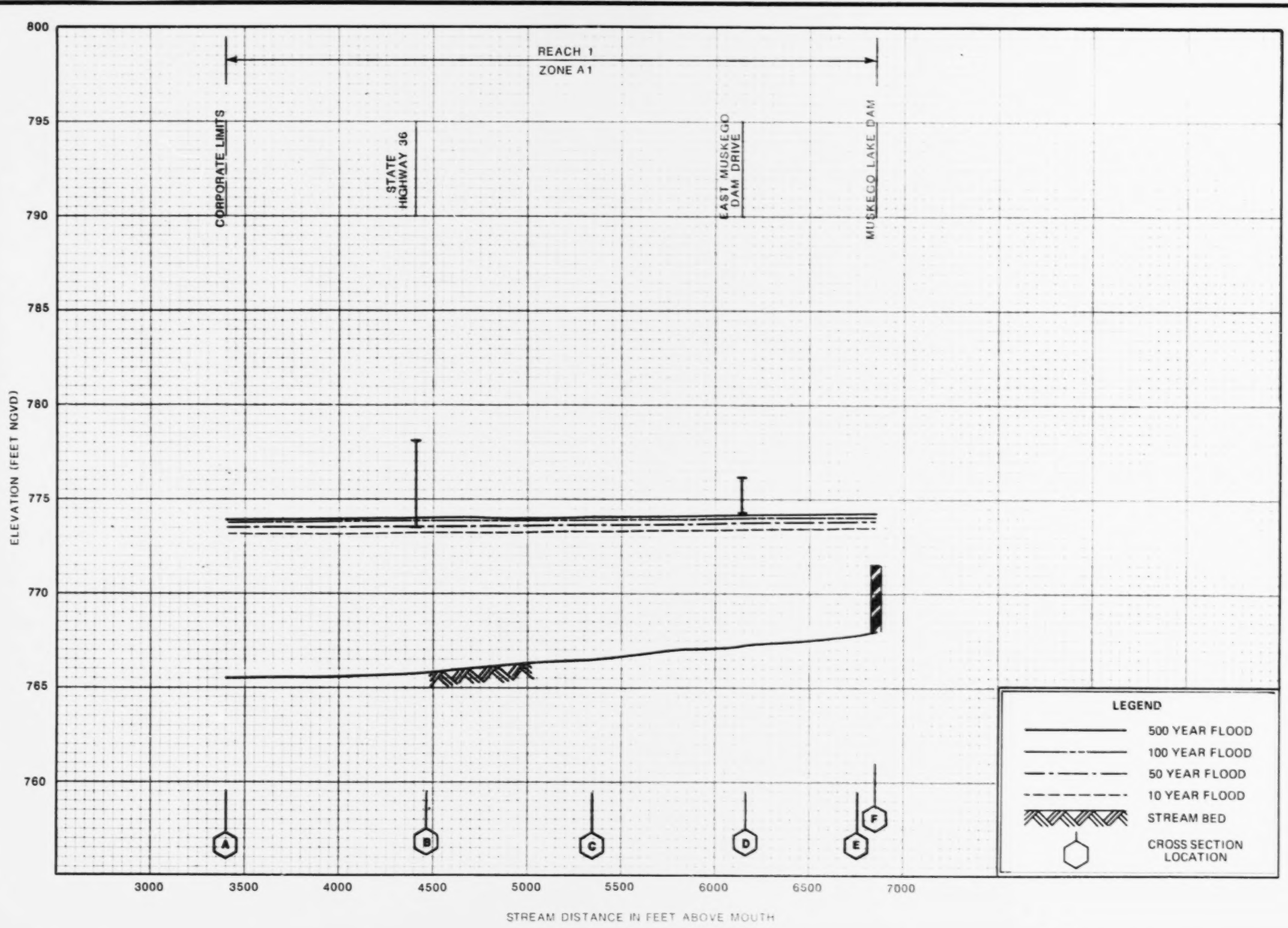

FLOOD PROFILES

MUSKEGO CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI
(WAUKESHA CO.)

04P

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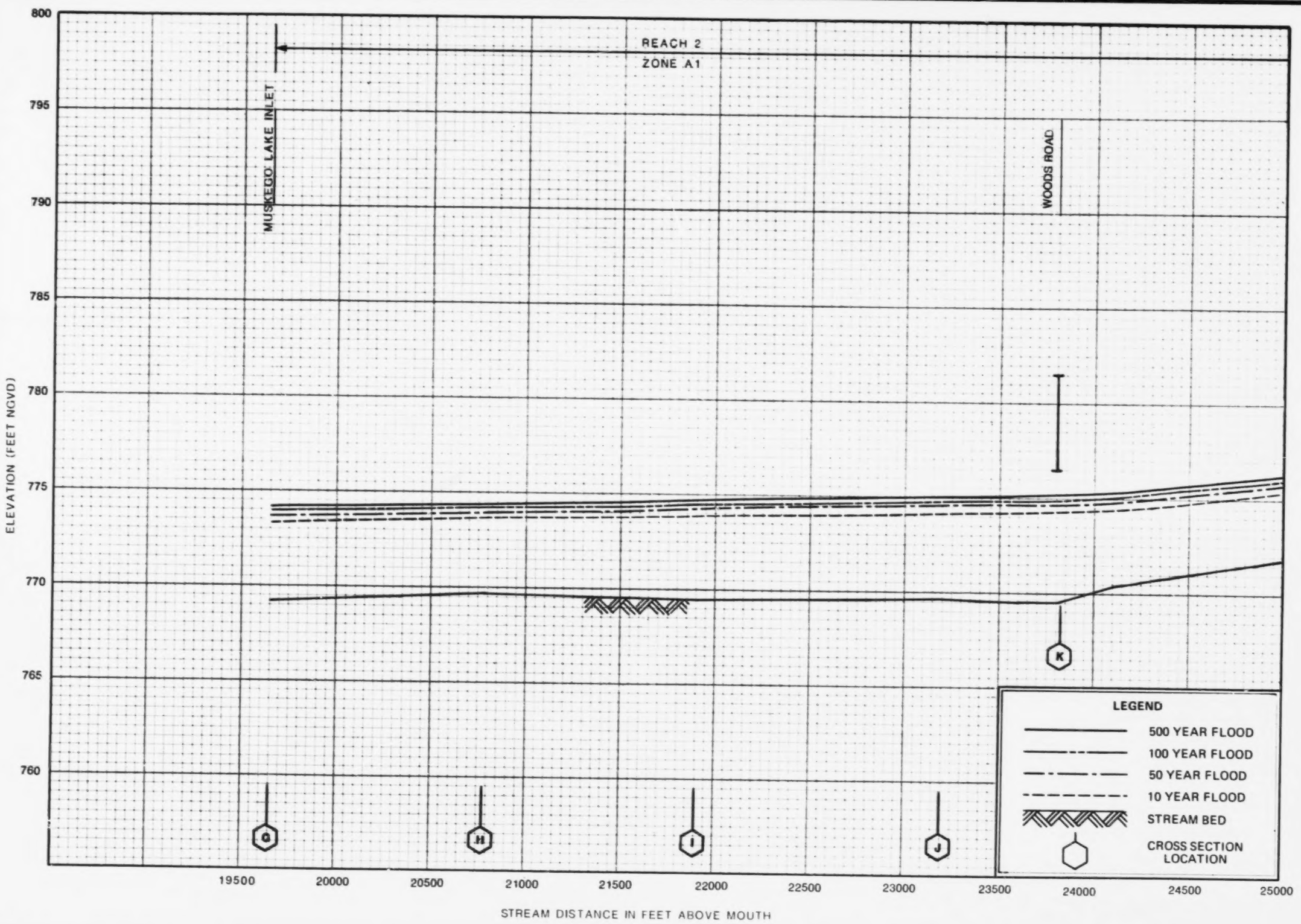

FLOOD PROFILES

MUSKEGO CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI
(WAUKESHA CO.)

05P

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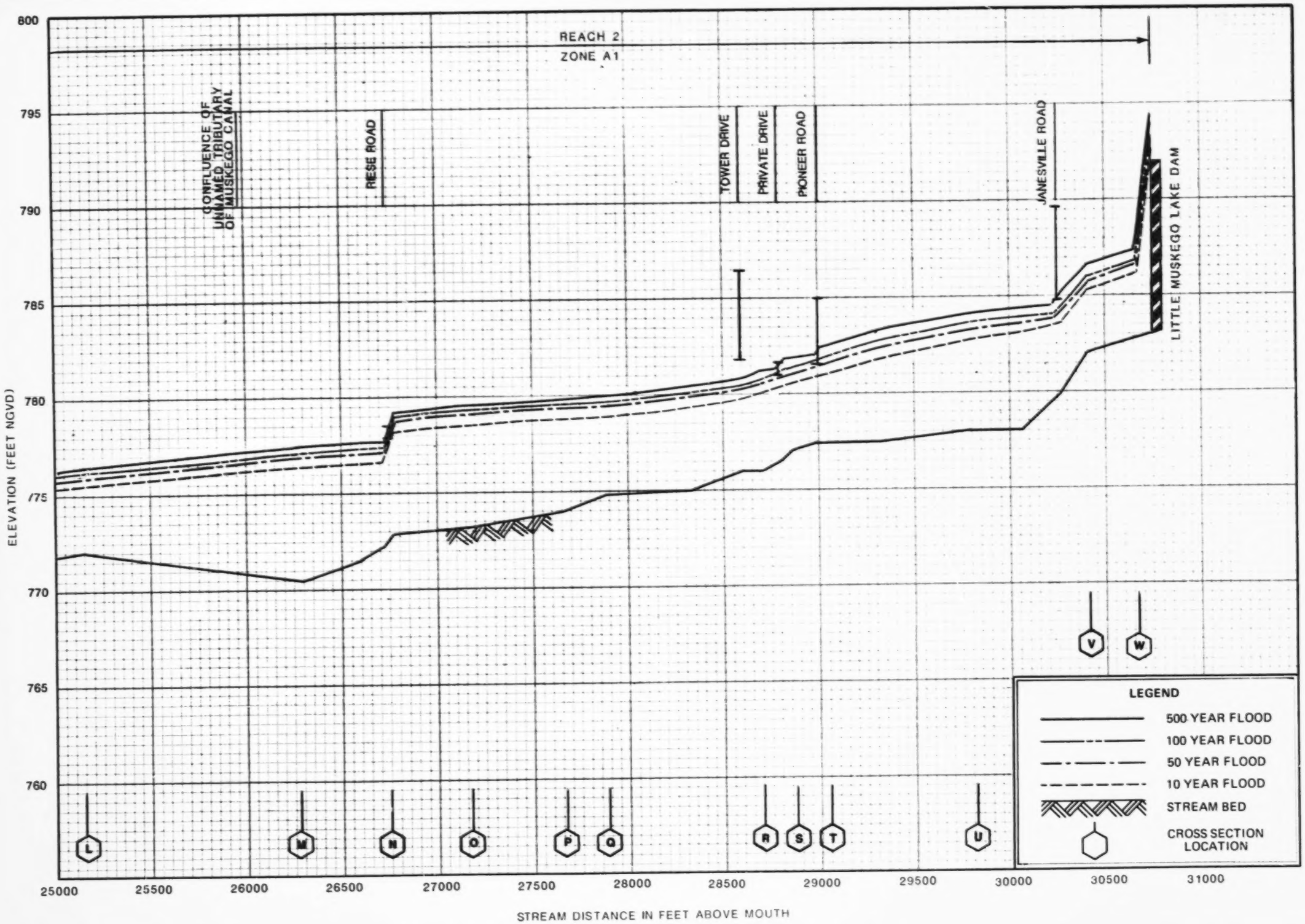

FLOOD PROFILES

MUSKEGO CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI
(WAUKESHA CO.)

06P

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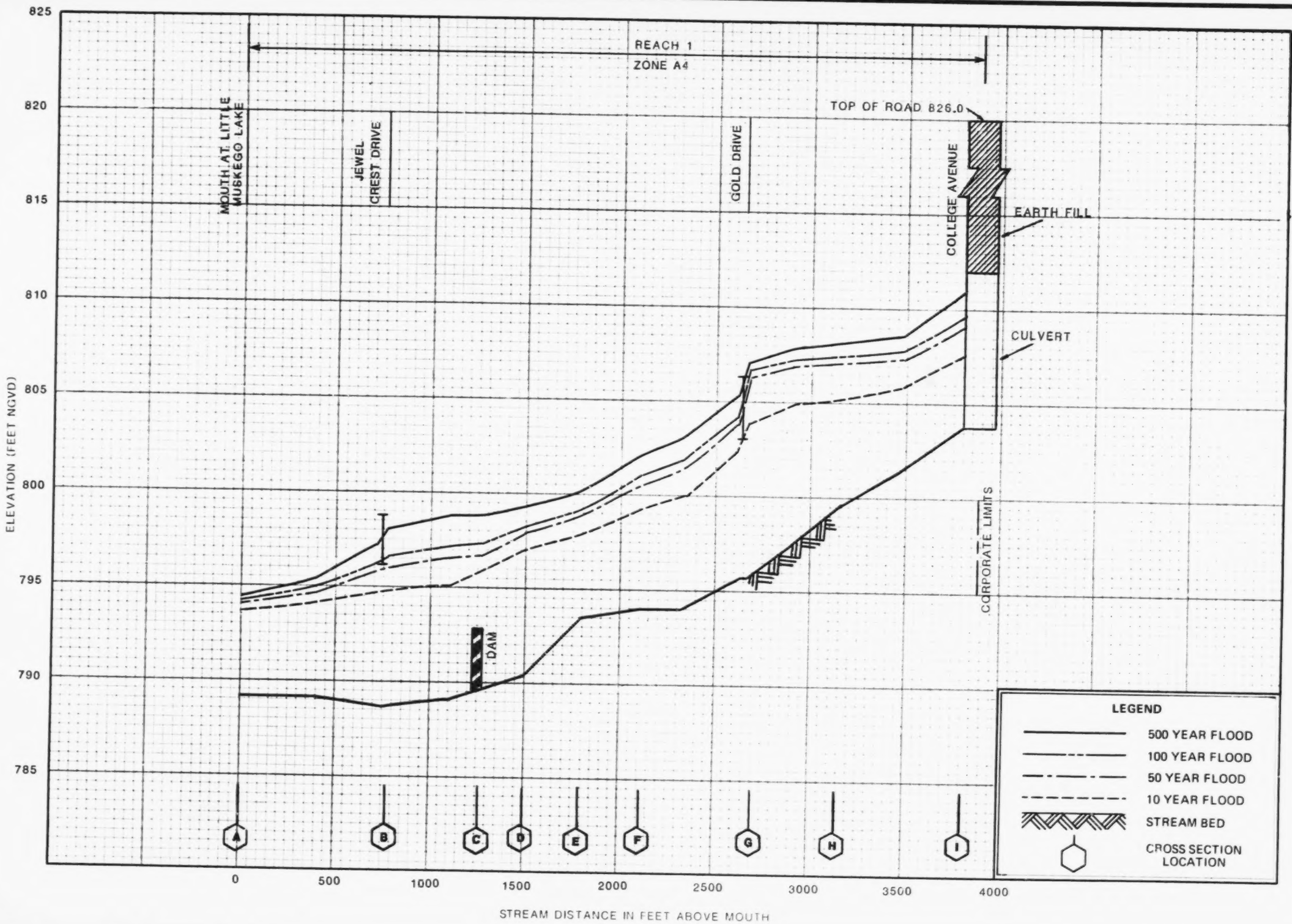

FLOOD PROFILES

JEWEL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI
(WAUKESHA CO.)

07P

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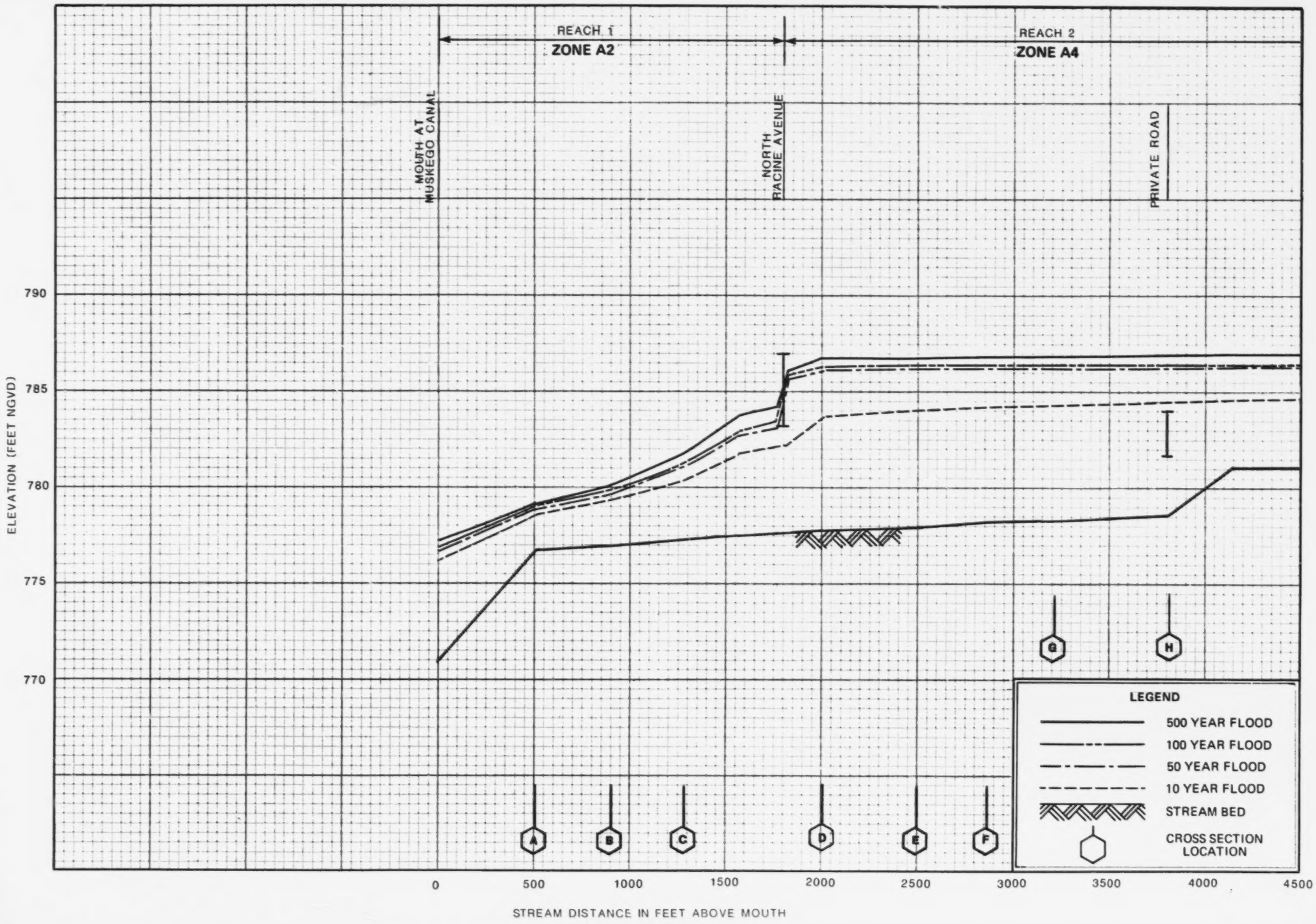

FLOOD PROFILES

UNNAMED TRIBUTARY OF MUSKEGO CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI
(WAUKESHA CO.)

08P

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REACH 2
ZONE A4

PRIVATE ROAD

LIMIT OF DETAILED STUDY

805
800
795
790
785
780

ELEVATION (FEET NGVD)

I J K L M N O

4500 5000 5500 6000 6500 7000 7500 8000

STREAM DISTANCE IN FEET ABOVE MOUTH

LEGEND

- 500 YEAR FLOOD
- 100 YEAR FLOOD
- 50 YEAR FLOOD
- 10 YEAR FLOOD
- STREAM BED
- CROSS SECTION LOCATION

FLOOD PROFILES

UNNAMED TRIBUTARY OF MUSKEGO CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI
(WAUKESHA CO.)

09P

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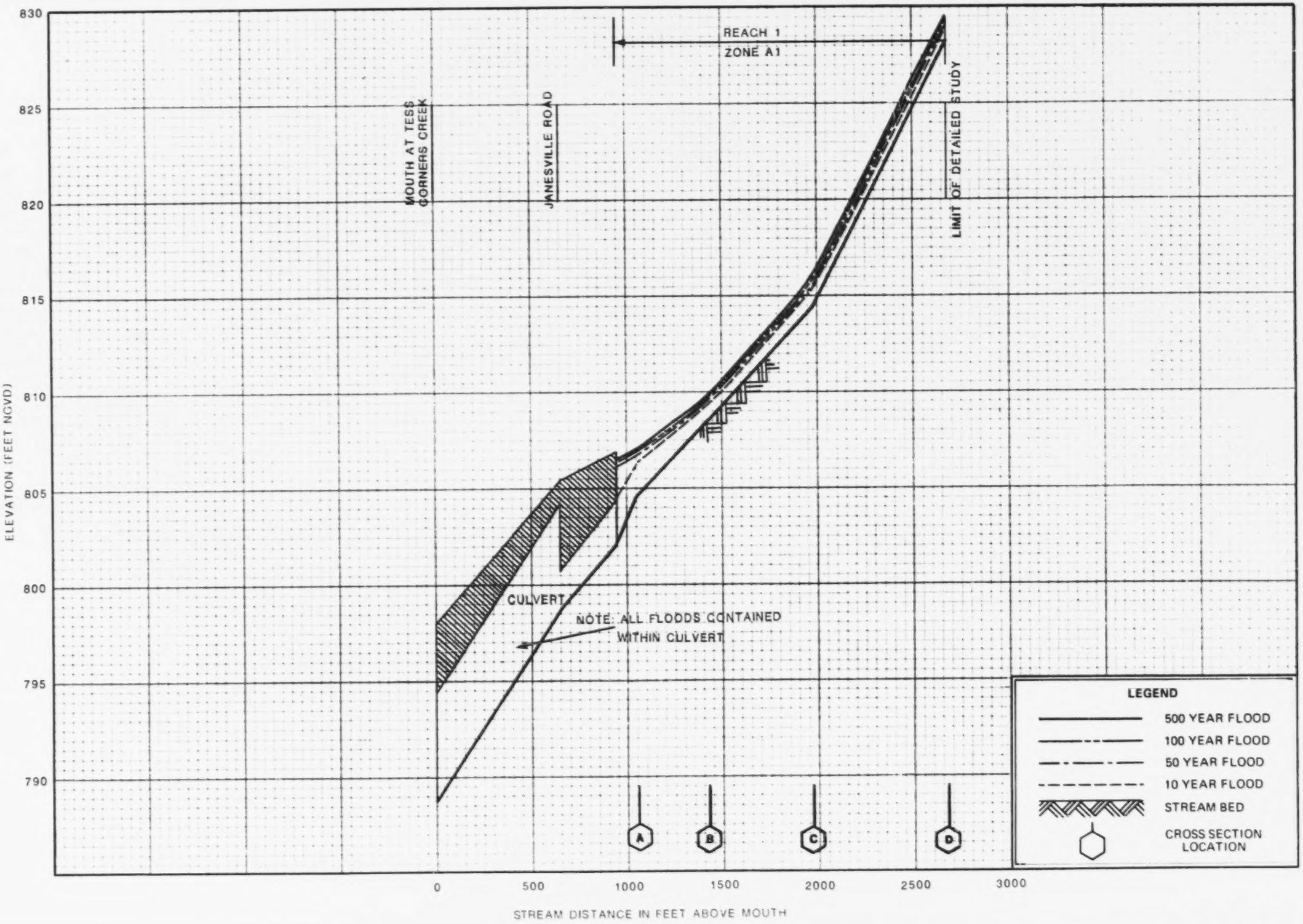


FLOOD PROFILES

TESS CORNERS CREEK TRIBUTARY NORTH

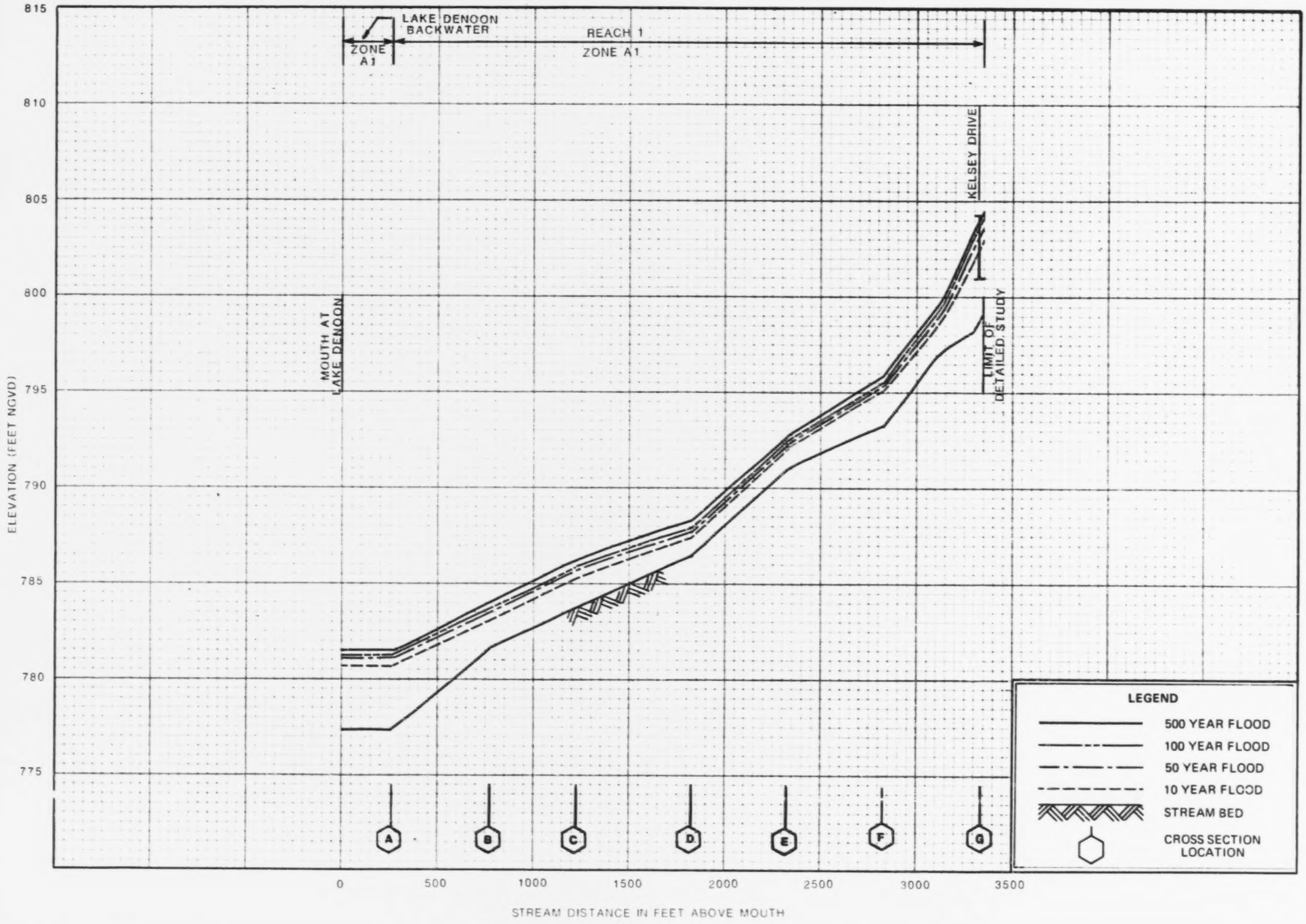
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI

(WAUKESHA CO.)

10P

BEST DOCUMENT AVAILABLE



FLOOD PROFILES

LAKE DENOON TRIBUTARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MUSKEGO, WI
(WAUKESHA CO.)

11P